Chapter 2
Background

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A wide variety of available information was reviewed and compiled for this updated and expanded study of the Bear River Basin groundwater resources. The updated data was obtained from regional and area-specific studies conducted by state and federal agencies in Wyoming, Idaho, and Utah. This chapter discusses the data sources, approach, organization, and computer-based mapping used in this current study and compares them to the previous Ground Water Resource Investigations contained within the 2001 and 2011 Bear River Basin Water Plans (Forsgren and Associates, 2001; Wyoming Water Development Office (WWDO), 2012).

The 2011 Bear River Water Basin Plan (WWDO, 2012) and associated technical memoranda constitute the most recent of the studies completed by the WWDO between 2000 and 2011 for Wyoming's seven major drainage basins. The 2011 plan provides extensive information about the cultural and physical settings of the basin both generally and as they relate to groundwater resources. In order to avoid repetition, the 2011 plan and 2007 Wyoming Framework Water Plan that summarizes and updates the 2001 Bear River Basin Plan – Forsgren and Associates (2001) are cited frequently in this study and where appropriate, links are provided to online information.

2.1 Sources of data

Agencies that contributed data and information for this study include:

BLM	U.S. Bureau of Land Management
EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
	University of Wyoming Libraries
WRDS	University of Wyoming Water Resources Data System
DEQ	Wyoming Department of Environmental Quality
WyGISC	Wyoming Geographical Information Science Center
WOGCC	Wyoming Oil and Gas Conservation Commission
WRRI	Wyoming Water Resources Research Institute
SEO	Wyoming State Engineer's Office
WSGS	Wyoming State Geological Survey
WWDC	Wyoming Water Development Commission
WWDO	Wyoming Water Development Office

2.2 Previous regional-scale investigations

Several surface water and groundwater management studies have been previously conducted for areas contained wholly or partly within the Bear River Basin. The geographic scale of the earlier projects varies considerably. This study builds on those previous compilations. The primary hydrogeologic studies and associated supporting geologic investigations of the basin area are listed below in approximate chronologic order by agency and author(s):

- *U.S. Geological Survey Hydrologic Investigation Atlases*
  1968 - Welder, G.E., 1968, Groundwater reconnaissance of the Green River Basin, southwestern Wyoming: U.S. Geological Survey Hydrologic Investigations Atlas HA-290, 1 map on 2 sheets, scale 1:250,000, text 5 p.
  1975 - Lines, G.C., and Glass, W.R., 1975, Water resources of the thrust belt of western Wyoming: U.S. Geological Survey Hydrologic Investigations Atlas HA-539, map scale 1:250,000, 3 sheets.
  1996 - Whitehead, R.H., 1996 Ground water atlas of the United States, Segment 8, Montana, North Dakota, South Dakota, Wyoming: U.S. Geologic Survey Hydrologic Investigations Atlas HA-730-I, 24 p.

- *Basin studies by the University of Wyoming, Water Resources Research Institute, and the Wyoming Natural Resource Board*

  1962 - Dana G. F., 1962, Groundwater reconnaissance study of the State of Wyoming, part 4. Green River basin: Prepared for Wyoming Natural Resource Board, Cheyenne, 355 p.

  1981 - Ahern, J., Collentine, M., and Cooks, S., 1981, Occurrence and characteristics of groundwater in the Green River Basin and Overthrust Belt, Wyoming: Report to U.S. EPA, Contract Number G-008269-79, by Water Resources Research Institute, University of Wyoming, Laramie, Wyoming, Volume V-A and Volume V-B (Pl.s), 2volumes, 123 p.

- *Wyoming State Geological Survey publications*

  1937 - Geological Survey of Wyoming, 1937, Geologic map of Uinta County, Wyoming: Compiled from all available data by the Geological Survey of Wyoming in cooperation with the Wyoming State Planning Board, Geological Survey of Wyoming, map scale 1:253,440 (1 inch = 4 miles), 1 sheet (rolled).

  1993 - Love, J.D., Christiansen, A.C., and Ver Ploeg, A.J., *compilers*, 1993, Stratigraphic chart showing the Phanerozoic nomenclature for the State of Wyoming: Geological Survey of Wyoming Map Series 41 (MS-41), no scale, 1 sheet.

  1993 - Royse, F., Jr., 1993, An overview of the geologic structure of the thrust belt in Wyoming, northern Utah, and eastern Idaho: *in* Snoke, A.W., Steidtmann, J.R., and Roberts, S.M., Eds., Geology of Wyoming: Geological Survey of Wyoming Memoir No. 5, p. 272-311.

- *U.S. Geological Survey Water Supply Papers, Professional Papers, Scientific Investigation Reports, Scientific Investigation Maps, Open-File Reports, Water Resource Investigations Reports, and Circulars.*

  1906 - Veatch, A.C., 1906, Coal and oil in southern Uinta County, Wyoming: U.S. Geological Survey Bulletin 285-F, Contributions to Economic Geology, p. 331-353.

  1907 - Veatch, A.C., 1907, Geography and geology of a portion of southwestern Wyoming, with special reference to oil and coal: U.S. Geological Survey Professional Paper 56, 26 plates, 178 p.

  1961 - Rubey, W.W., Oriel, S.S., and Tracey, J.I., Jr., 1961, Age of the Evanston Formation, western Wyoming: U.S. Geological Survey Professional Paper 424-B, Geological Survey Research 1961: Short Papers in the Geologic and Hydrologic Sciences, Article 64, p. B153-B154.

  1963 - Robinove, C.J., and Berry, D.W., 1963, Availability of ground water in the Bear River valley, Wyoming, *with a section on* Chemical quality of the water, by J.G. Connor: U.S. Geological Survey Water-Supply Paper 1539-V, 44 p., 2 pl.

  1963 - Robinove, C.J., and Cummings, T.R., 1963, Ground-water resources and geology of the Lyman – Mountain View area, Uinta County, Wyoming: U.S. Geological Survey Water-Supply Paper 1669-E, 1 plate, 43 p.

  1969 - Hansen, W.R., 1969, The geologic story of the Uinta Mountains: U.S. Geological Survey Bulletin 1291, second printing 1975, 144 p.

  1973 – Rubey, W.W., 1973a, Geologic map of the Afton quadrangle and part of the Big Piney quadrangle, Lincoln and Sublette counties, Wyoming: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-686, map scale 1:62,500, 2 sheets.

  1973 - Rubey, W.W., 1973b, New Cretaceous formations in the western Wyoming thrust belt: U.S. Geological Survey Bulletin

1372-I, Contributions to Stratigraphy, 35 p.
1976 - Rubey, W.W., Oriel, S.S., and Tracey, J.I., Jr., 1976, Geologic map of the Cokeville 30-minute quadrangle, Lincoln and Sublette counties, Wyoming: U.S. Geological Survey Open-File Report 76-597 (OFR 76-597), map scale 1:62,500, 1 sheet.
1980 - Oriel, S.S., and Platt, L.B., 1980, Geologic map of the Preston 1° x 2° quadrangle, southeastern Idaho and western Wyoming: U.S. Geological Survey Miscellaneous Investigations Map I-1127, scale 1:250,000, 1 sheet.
1980 - Rubey, W.W., Oriel, S.S., and Tracey, J.I., Jr., 1980, Geologic map and structure sections of the Cokeville 30-minute quadrangle, Lincoln and Sublette counties, Wyoming: U.S. Geological Survey Miscellaneous Investigations Series Map I-1129, map scale 1:62,500, 2 sheets.
1983 – Gibbons, A.B., and Dickey, D.D., 1983, Quaternary faults in Lincoln and Uinta counties, Wyoming, and Rich County, Utah: U.S. Geological Survey Open-File Report 83-288 (OFR 83-288), map scale 1:100,000, 1 sheet.
1985 - Love, J.D., and Christiansen, A.C., *compilers*, 1985, Geologic map of Wyoming: U.S. Geological Survey, map scale 1:500,000, 3 sheets.
1985 - Lowham, H.W., Peterson, D.A., Larson, L.R., Zimmerman, E.A., Ringen, B.H., and Mora, K.L., 1985, Hydrology of Area 52, Rocky Mountain Coal Province, Wyoming, Colorado, Idaho, and Utah: U.S. Geological Survey Water-Resources Investigations/Open-File Report 83-761, Cheyenne, Wyoming, October 1985, 96 p.
1986 - Gibbons, A.B., 1986a, Surficial materials map of the Evanston 30' x 60' quadrangle, Uinta and Sweetwater counties, Wyoming: U.S. Geological Survey Coal Map C-103, map scale 1:100,000, 1 sheet.
1986 – Gibbons, A.B., 1986b, Surficial materials map of the Kemmerer 30' x 60' quadrangle, Lincoln, Uinta, and Sweetwater counties, Wyoming: U.S. Geological Survey Coal Map C-102, map scale 1:100,000, 1 sheet.
1990 – Glover, K.C., 1990, Stream-aquifer system in the Upper Bear River valley, Wyoming: U.S. Geological Survey Water-Resources Investigations Report 89-4173, Cheyenne, Wyoming, 58 p.
1992 - M'Gonigle, J.W., and Dover, J.H., 1992, Geologic map of the Kemmerer 30' x 60' quadrangle, Lincoln, Uinta, and Sweetwater counties, Wyoming: U.S. Geological Survey Miscellaneous Investigations Series Map I-2079, map scale 1:100,000, 1 sheet.
1993 - Smith, M.E., and Maderak, M.L., 1993, Geomorphic and hydraulic assessment of the Bear River in and near Evanston, Wyoming: U.S. Geological Survey Water-Resources Investigations Report 93-4032, 61 p.
1995 - Ogle, K.M., Eddy-Miller, C.A., and Busing, C.J., 1996, Estimated use of water in Lincoln County, Wyoming, 1993: U.S. Geological Survey Water-Resources Investigations Report 96-4162, 13 p.
1996 - Eddy-Miller, C.A., Plafcan, M., and Clark, M.L., 1996, Water resources of Lincoln County, Wyoming: U.S. Geological Survey Water-Resources Investigations Report 96-4246, 131 p, 3 pl.
2000 - Eddy-Miller, C.A., and Norris, J.R., 2000, Pesticides in groundwater - Lincoln County, Wyoming, 1998-99: U.S. Geological Survey Fact Sheet FS-033-00, 1 folded sheet, 4 p.
2004 - Eddy-Miller, C.A., and Remley, K.J., 2004, Pesticides in groundwater - Uinta County, Wyoming, 2002-03: U.S. Geological Survey Fact Sheet 2004-3093, 1 folded sheet, 4 p.
2013 - Eddy-Miller, C.A., Bartos, T.T., and Taylor, M.L., 2013, Pesticides in Wyoming groundwater, 2008–10: U.S. Geological Survey Scientific Investigations Report 2013–5064, 45 p.

- *Wyoming Water Development Commission Studies*

  1991 - Johnson-Fermelia Company, Inc., 1991, Phase 1 report, Cokeville water supply study project level I: prepared for the WWDO, various pagination.

  1992 – TriHydro Corporation, 1992, Phase I report: Level II feasibility study, ground-water alternatives investigation, Cokeville, Wyoming: Consultant's report prepared for the WWDO, Cheyenne, Wyoming, and Forsgren Associates, Evanston, Wyoming; prepared for WWDO, various pagination.

  1993 - Forsgren Associates, 1993a, Cokeville water supply level II study, final report: prepared for the WWDC and the Town of Cokeville, various pagination.

  1993 - Forsgren Associates, 1993b, in association with Chen Northern, Inc., and Trihydro Corporation, Cokeville water supply level II study, supplemental reports: prepared for the WWDC and the Town of Cokeville, Wyoming, various pagination.

  1993 - TriHydro Corporation, 1993, Phase II report, Well construction and testing program, level II feasibility study, Cokeville, Wyoming, *in* Forsgren Associates, 1993, in association with Huntingdon Chen-Northern, Inc., and TriHydro Corporation, Cokeville water supply level II study, supplemental reports: report prepared for the WWDC and the Town of Cokeville, various pagination.

  1995 - TriHydro Corporation, 1995, Level III construction and testing report, Cokeville No. 2 and Cokeville No. 3 municipal water supply wells, Cokeville, Wyoming (draft): prepared for the WWDC and the Town of Cokeville, various pagination.

  1997 - Sunrise Engineering, 1997, Evanston water system master plan level II study: prepared for the WWDO, various pagination.

  2000 - TriHydro Corporation, 2000, Hydrogeologic report: North Uinta County improvement and service district water supply master plan, Uinta County, Wyoming: prepared for the WWDC and the North Uinta County Improvement and Service District, various pagination.

  2000 - Forsgren Associates, 2000, North Uinta County Improvement and Service District water supply master plan level I, final report: prepared for the WWDC and the North Uinta County Improvement and Service District, various pagination.

  2001 - Forsgren Associates, Inc., 2001, in association with Anderson Consulting Engineers, Inc., Leonard Rice Engineers, Inc., and BBC Research & Consulting, Bear River basin plan, final report: prepared for the WWDO, 96 p., Appendices. [http://waterplan.state.wy.us/plan/bear/bear-plan.html]

  2003 - TriHydro Corporation, 2003, in association with Forsgren Associates, North Uinta water supply project level II feasibility study, Bear River, Wyoming, final report: prepared for the WWDC and the North Uinta County Improvement and Service District, various pagination.

  2005 - Sunrise Engineering, 2005, in association with Fassett Consulting, LLC., Evanston/Bear River regional pipeline level II study: prepared for the WWDO, various pagination.

  2007 - WWC Engineering, Inc., 2007, in association with Hinckley Consulting, Collins Planning Associates, Greenwood Mapping, Inc., and States West Water Resources Corporation, Wyoming framework water plan: prepared for the WWDO, Cheyenne, Wy., v. 1 and 2, various pagination. [http://waterplan.state.wy.us/]

  2012 - WWDO, 2012, in association with the State Engineer's Office and

U.W. Water Resources Data System, 2011 Bear River Basin plan update, final report, technical memoranda, GIS products and hydrologic models, various pagination.

2.3 Current WWDC and USGS regional-scale investigations

In addition to these existing studies, the WWDC is conducting a review of the previous Bear River Basin Water Plan (WWDO, 2012) and constructing a hydrological model for surface flows in the basin. The U.S. Geological Survey (USGS) is not currently conducting any specific hydrogeologic investigations in the basin but continues to collect real time streamflow data and periodic water quality at eight USGS stream gaging stations located in the Wyoming Bear River Basin.

2.4 Current Available Groundwater Determination

The previous investigations, that examined the hydrogeology of geographic areas of varying scale that fall partly or entirely within the Bear River Basin were generally based on structural basins, counties, or other specific areas of interest (USGS studies). The study area of this and the previous memoranda (Forsgren Associates, Inc., 2001; WWDO, 2012) include the surface drainages of the Bear River that lie within the borders of the state of Wyoming as well as small watersheds in Idaho and Utah that are tributary to the Wyoming Bear River Basin (**Fig. 3-1**).

A detailed hydrostratigraphy of the Bear River Basin was developed by the USGS for this study based on stratigraphic regions by Love and others (1993). Development of the updated hydrostratigraphy is described in **Chapter 7** and summarized on hydrostratigraphic nomenclature charts (**Pl. 5**), and on **Plate 2**, a surface hydrogeologic map and hydrostratigraphic chart for the overall Bear River Basin.

This updated Available Groundwater Determination provides expanded information on several topics, developed to more fully characterize the groundwater resources of the Bear River Basin:

- Effects of structure on groundwater distribution and flow (**Section 5.4** and **Chapter 7**).
- Aquifer vulnerability and potential sources of groundwater contamination (**Section 5.6**.
- Comparisons of calculated aquifer-specific recharge volumes with updated precipitation data, and current and projected beneficial uses (**Section 6.2**).
- A basin-wide water balance (**Chapter 8**).
- A detailed listing and summary of historic groundwater development studies by the WWDC in the Bear River Basin (**Appendix B**).
- A list of technical terms and concepts commonly used in groundwater science (**Section 5.1.1**).

2.5 Maps

Progressive improvements in geographic information system (GIS) technology have greatly enhanced the geologist's ability to process and present large, complex, geospatially-linked datasets for natural resource evaluations. To meet the objectives of this updated Available Groundwater Determination, the WSGS and USGS developed a series of maps to present and evaluate the extensive digital data resources available on Bear River Basin groundwater resources. Several maps were generated wholly or primarily from existing GIS databases compiled specifically for this study. Some of the maps and layers were supplemented with information scanned or digitized from existing hard copy maps into GIS-supported formats.

The accuracy of any map or figure depends on the accuracy of the original data and the methods used to process it. Frequently, data processing for large compilations requires correlation between multiple, disparate datasets. The limitations of the data used in digital mapping make it necessary for the analyst to provide the reader with interpretive qualifications regarding the reliability of the produced maps and Figures. This memorandum

provides discussions of data limitations and cites data sources for each map and figure presented.

Additionally, *metadata* (qualifying information on the GIS datasets) is commonly furnished along with the GIS data. Metadata provides structured and detailed descriptive information about the data resources used to develop GIS map layers. Metadata facilitates the understanding, use, and management of the data by defining its sources, locations, formats, attributes, processing, limitations, disclaimers, etc. Where appropriate, the metadata includes contact information where additional information can be obtained. The metadata associated with the Bear River Basin maps are provided on-line at http://waterplan.state.wy.us/plan.

WSGS and USGS generated the maps for this study in two formats. Plate-scale maps use 1:380,000 scale (1 inch = 6 miles). Figure-scale maps use variable scales that allow the maps to fit either 8½ × 11-inch, or 11 × 17-inch sheets depending on the amount of data presented and readability considerations.